TETRA TECH

June 12, 2008

Mr. Roy Crossland
START Project Officer
U.S. Environmental Protection Agency, Region 7
901 North 5th Street
Kansas City, Kansas 66101

Subject: **Lead Trend Analysis – Evaluation by Individual Quadrants**
Herculaneum Lead Smelter, Herculaneum, Missouri
U.S. EPA Region 7 START 3, Contract No. EP-S7-06-01, Task Order No. 0021
Task Monitor: Bruce Morrison, On-Scene Coordinator

Dear Mr. Crossland:

Tetra Tech EM Inc. is submitting the attached updated Lead Trend Analysis at the Herculaneum Lead Smelter. Tetra Tech has updated the trend analysis to include the latest round of data obtained in March 2008. If you have any questions or comments, please contact the program manager at (816) 412-1754 or me at (816) 412-1762.

Sincerely,

David Homer, Ph.D.
Project Manager

Ted Faile, P.G.
START Program Manager

cc: Bruce Morrison, EPA

Enclosures

30268098

Tetra Tech EM Inc.
415 Oak Street, Kansas City, MO 64106
Tel 816.412.1741 Fax 816.410.1748 www.tetratech.com

LEAD SOIL TREND ANALYSIS THROUGH MARCH 2008
EVALUATION BY INDIVIDUAL QUADRANT

HERCULANEUM LEAD SMELTER
HERCULANEUM, MISSOURI

CERCLIS ID: MOD006266373

Superfund Technical Assessment and Response Team (START) 3 Contract
Contract No. EP-S7-06-01, Task Order 0021

Prepared For:

U.S. Environmental Protection Agency
Region 7
Superfund Division
901 North 5th Street
Kansas City, Kansas 66101

June 12, 2008

Prepared By:

Tetra Tech EM Inc.
415 Oak Street
Kansas City, Missouri 64106
816-412-1741

INTRODUCTION

Tetra Tech EM Inc. (Tetra Tech) was tasked by the U.S. Environmental Protection Agency (EPA) Region 7 Enforcement/Fund Lead Removal program to conduct a trend analysis of soil lead concentrations at selected locations within Herculaneum, Missouri (City). Specifically, the Tetra Tech Superfund Technical Assessment and Response Team (START) 3 was requested to review and analyze data that would enable EPA to determine if soil lead concentrations were increasing over time at a variety of locations within the City. The specific task was to perform a trend analysis for individual quadrants within each yard using the most current sampling data. The assessment was conducted under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and the Superfund Amendments and Reauthorization Act of 1986. The project was assigned under START Contract No. EP-S7-06-01, Task Order No. 0021.

Tetra Tech focused its analysis on one data set called "Recontamination." This data set includes results from a number of residential properties. The data were collected from four different quadrants at each property, and additional data for several properties came from samples collected in driveway areas outside the quadrants. Lead sampling was conducted at each location at varying intervals from the time removal activities were completed in early 2002 (sampling round 6). Sampling was conducted monthly prior to 2003, quarterly from 2003 to 2004, and semi-annually after October 2005 (sampling round 22). This report includes results for sampling conducted between August 2002 (sampling round 7) and March 2008 (sampling round 26). Due to the sequence of removal activities, not all properties underwent the same number of sampling events; the number of events ranged from 7 to 20 events per quadrant for individual properties. At many locations, some intervals within the series were omitted because of weather or access restrictions. The lead concentrations were determined by use of a portable X-ray fluorescence (XRF) instrument. Samples were collected and analyzed in accordance with the quality assurance project plan (QAPP) dated September 11, 2001.

This document presents the methods used to evaluate changes in soil lead concentrations following the removal activities, and the results of this analysis.

METHODS

Trend tests were conducted for each property using data collected from round 7 (August 2002) through round 26 (March 2008). The non-parametric Mann-Kendall test was used to evaluate temporal trends for each sampled quadrant at the individual properties. The Mann-Kendall test is a widely used statistical test for detecting monotonic trends (that is, trends that are either increasing or decreasing) in time-series of

data (Gilbert 1987; Helsel and Hirsch 1992; Gibbons 1994). Because the Mann-Kendall test uses only the relative magnitude of the data rather than their measured values, it has a number of desirable properties: the data need not be normally distributed; and the test is not significantly affected by outliers, missing data, or censored data. Censored data are treated in the Mann-Kendall test by setting all nondetect values to a concentration slightly below the minimum detected concentration. It should be noted that a minimum of four sampling events are required to perform this test, so properties with fewer than four rounds of sampling were not evaluated. Properties not sampled during round 26 were also excluded from the trend analysis.

RESULTS

Temporal trends in lead concentrations for 10 properties are summarized in Table 1 and Figure 1. The trend analysis identified 9 out of 10 properties where at least one quadrant showed a statistically significant increasing trend. No statistically significant decreasing trends were identified for any properties. Three properties had increasing lead concentrations in all four quadrants: house numbers 9, 18, and 24. One property, house number 3, had increasing lead concentrations in three of four quadrants. Two properties had increasing lead concentrations in two of four quadrants: house numbers 7 and 76 (only two quadrants evaluated). Three properties had increasing lead concentrations in one quadrant: house numbers 10, 13, and 104. Only house number 103 showed no statistically significant trend in lead concentrations in any quadrant. All trend results are depicted graphically in Figure 1. Trend plots for individual properties are ordered by increasing distance from the smelter. Open symbols are used in Figure 1 to represent censored (nondetect) data, and solid symbols represent detected data.

Trend results reported for soil lead concentrations through sampling round 26 were similar to those reported during the last quarterly period, with the following exception. Quadrants from two properties that did not show increasing trends in round 25 (quadrant 3 from house number 10, and quadrant 2 from house number 104) showed statistically significant increasing trends in round 26. Note that houses 5, 6, 19, and 22 were sampled during round 25 but were not sampled during round 26.

REFERENCES

Gibbons, R. D. 1994. *Statistical Methods for Groundwater Monitoring*. John Wiley & Sons, Inc. New York, New York.

Gilbert, R. O. 1987. *Statistical Methods in Environmental Pollution Monitoring*. John Wiley & Sons, Inc. New York, New York.

Helsel, D. R. and R. M. Hirsh. 1992. *Statistical Methods in Water Resources*. Elsevier. New York, New York.

TABLE 1
RESULTS OF STATISTICAL TESTING FOR MONOTONIC TRENDS (MANN-KENDALL TEST) IN LEAD CONCENTRATION INDIVIDUAL QUADRANTS FOR SAMPLING ROUNDS 7 THROUGH 26
HERCULANEUM LEAD SMELTER SITE - HERCULANEUM, MISSOURI

Distance From Smelter[1]	House Number	Quadrant	Number of Sampling Events[2]	Number of Detected Samples	Sampling Event		Mann-Kendall Test Statistic[3] (S)	Probability > S	Trend Significant?[4] (Yes/No)	Direction of Trend
					First	Last				
0.10	76	Q1	13	13	10/30/2003	03/24/2008	55	0.001	**Yes**	**Increasing**
		Q2	13	13	10/30/2003	03/24/2008	44	0.006	**Yes**	**Increasing**
0.25	24	Q1	16	16	11/07/2002	03/24/2008	66	0.003	**Yes**	**Increasing**
		Q2	16	16	11/07/2002	03/24/2008	90	<0.001	**Yes**	**Increasing**
		Q3	16	16	11/07/2002	03/24/2008	78	0.000	**Yes**	**Increasing**
		Q4	16	15	11/07/2002	03/24/2008	63	0.004	**Yes**	**Increasing**
0.40	13	Q1	9	9	08/23/2002	03/26/2008	18	0.038	**Yes**	**Increasing**
		Q2	9	9	08/23/2002	03/26/2008	14	0.090	No	N/A
		Q4	9	8	08/23/2002	03/26/2008	16	0.060	No	N/A
0.54	9	Q1	19	19	08/22/2002	03/26/2008	90	0.002	**Yes**	**Increasing**
		Q2	19	19	08/22/2002	03/26/2008	85	0.003	**Yes**	**Increasing**
		Q3	19	19	08/22/2002	03/26/2008	95	0.001	**Yes**	**Increasing**
		Q4	19	18	08/22/2002	03/26/2008	86	0.002	**Yes**	**Increasing**
0.60	18	Q1	20	20	08/23/2002	03/26/2008	100	0.001	**Yes**	**Increasing**
		Q2	20	19	08/23/2002	03/26/2008	83	0.006	**Yes**	**Increasing**
		Q3	20	20	08/23/2002	03/26/2008	109	<0.001	**Yes**	**Increasing**
		Q4	20	20	08/23/2002	03/26/2008	112	<0.001	**Yes**	**Increasing**
0.75	3	Q1	20	17	08/23/2002	03/25/2008	50	0.056	No	N/A
		Q2	20	18	08/23/2002	03/25/2008	86	0.004	**Yes**	**Increasing**
		Q3	20	19	08/23/2002	03/25/2008	83	0.006	**Yes**	**Increasing**
		Q4	20	19	08/23/2002	03/25/2008	113	<0.001	**Yes**	**Increasing**
	10	Q1	8	6	08/22/2002	03/25/2008	11	0.114	No	N/A
		Q2	8	3	08/22/2002	03/25/2008	14	0.054	No	N/A
		Q3	8	4	08/22/2002	03/25/2008	19	0.012	**Yes**	**Increasing**
		Q4	8	3	08/22/2002	03/25/2008	14	0.054	No	N/A
0.79	103	Q1	7	3	03/28/2005	03/25/2008	11	0.068	No	N/A
		Q2	7	3	03/28/2005	03/25/2008	5	0.281	No	N/A
		Q3	7	3	03/28/2005	03/25/2008	7	0.191	No	N/A
		Q4	7	5	03/28/2005	03/25/2008	4	0.334	No	N/A
0.80	7	Q1	20	20	08/23/2002	03/26/2008	23	0.154	No	N/A
		Q2	20	17	08/23/2002	03/26/2008	77	0.009	**Yes**	**Increasing**
		Q3	20	16	08/23/2002	03/26/2008	39	0.093	No	N/A
		Q4	20	15	08/23/2002	03/26/2008	78	0.008	**Yes**	**Increasing**
1.00	104	Q1	7	5	03/28/2005	03/25/2008	-4	0.334	No	N/A
		Q2	7	5	03/28/2005	03/25/2008	15	0.015	**Yes**	**Increasing**
		Q4	7	3	03/28/2005	03/25/2008	3	0.386	No	N/A

Notes:

1 Properties are ordered as a function of increasing distance from the smelter.

2 Trend tests were not conducted for properties with fewer than four rounds of sampling, or for properties that were not sampled during round 26

3 All censored (nondetect) measurements were set equal to a concentration slightly lower than the minimum detected value

4 Monotonic trends are significant for probabilities less than or equal to 0.05; significant negative values for the Mann-Kendall test statistic indicate that trends are decreasing; and significant positive values for the Mann-Kendall test statistic indicate that trends are increasing.

N/A No significant trend identified.

14/36

6/96 INCREASING

FIGURE 1. Lead Concentration Trends From Round 7 Through 26, Houses Sorted By Increasing Distance From the Smelter

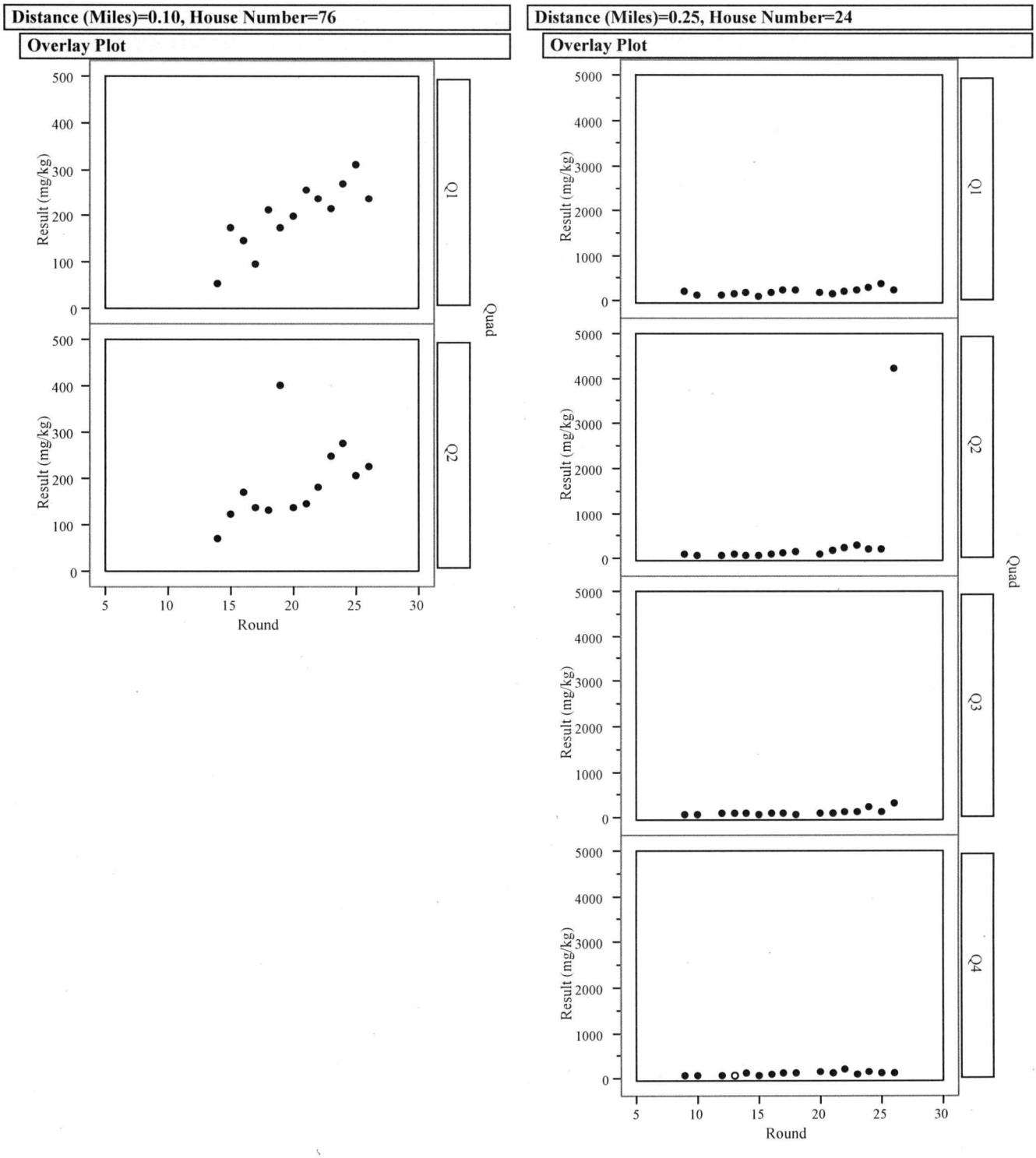
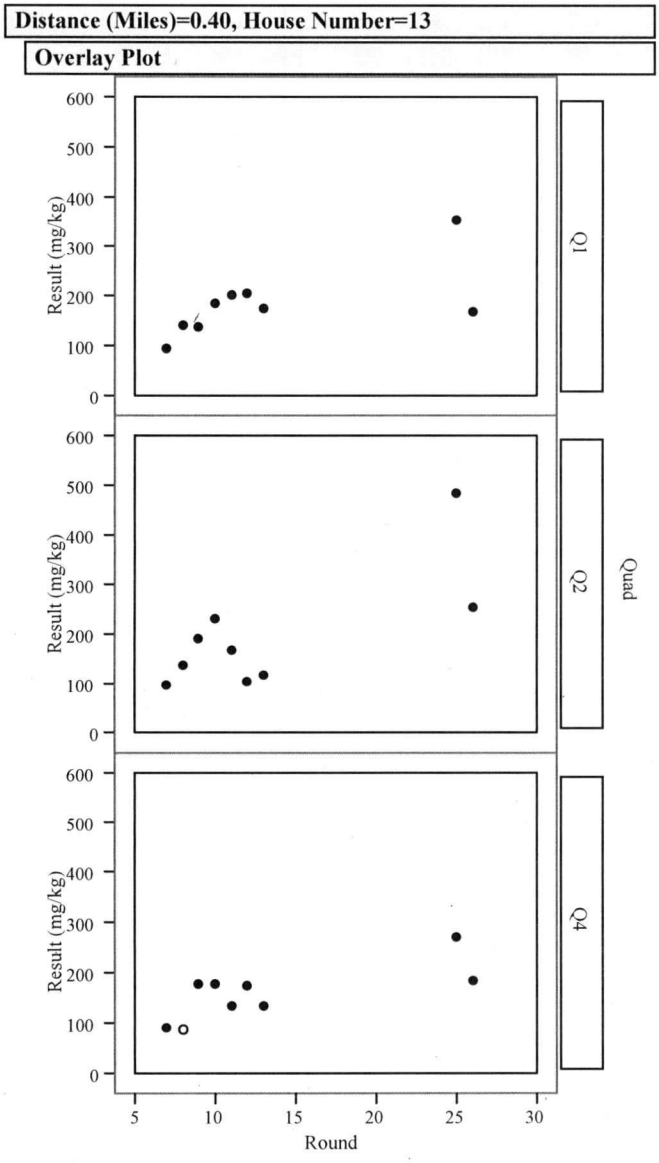


FIGURE 1. Lead Concentration Trends From Round 7 Through 26, Houses Sorted By Increasing Distance From the Smelter (Cont)



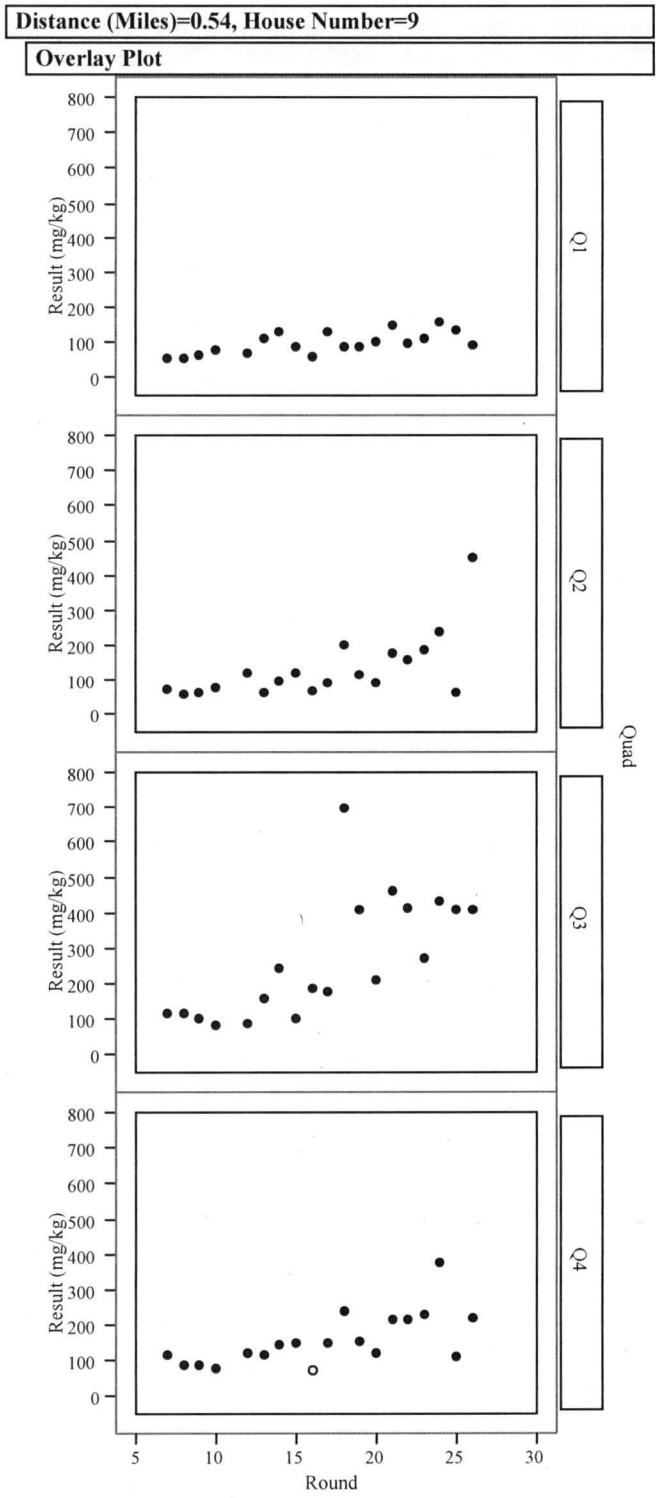
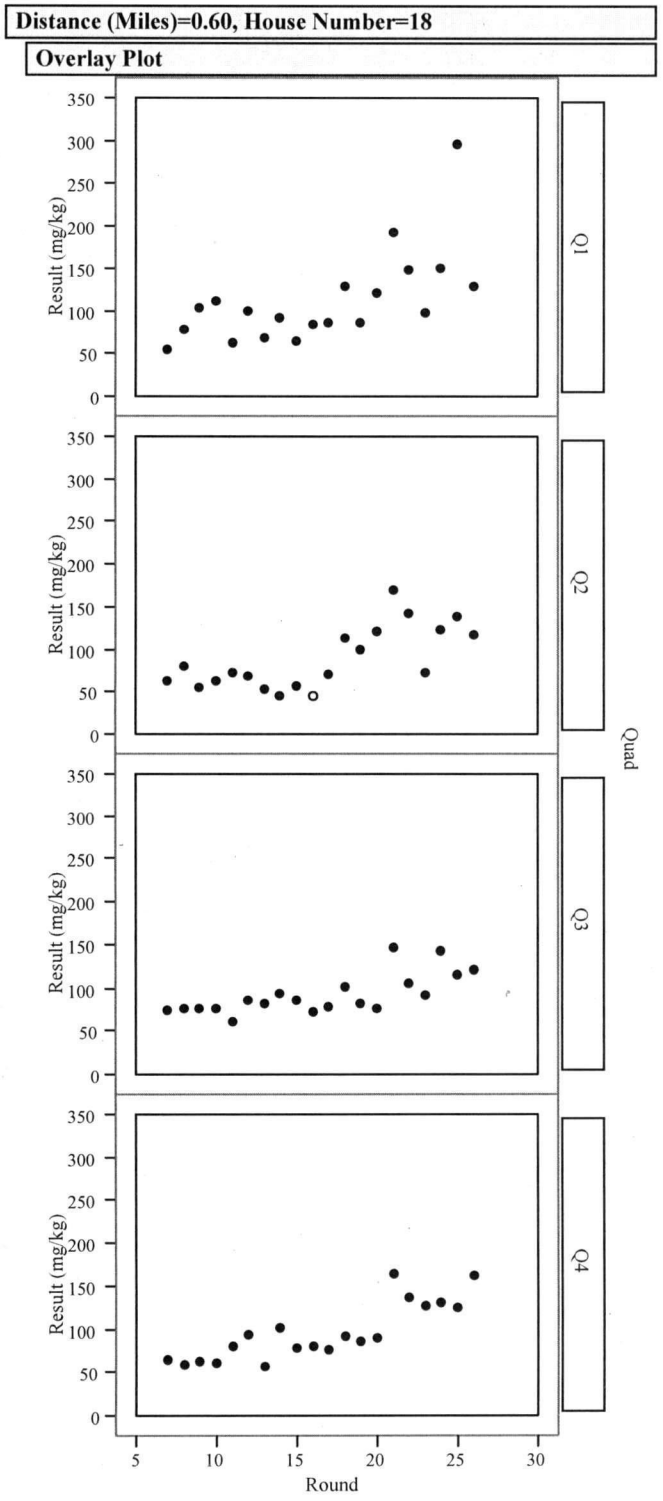


FIGURE 1. Lead Concentration Trends From Round 7 Through 26, Houses Sorted By Increasing Distance From the Smelter (Cont)



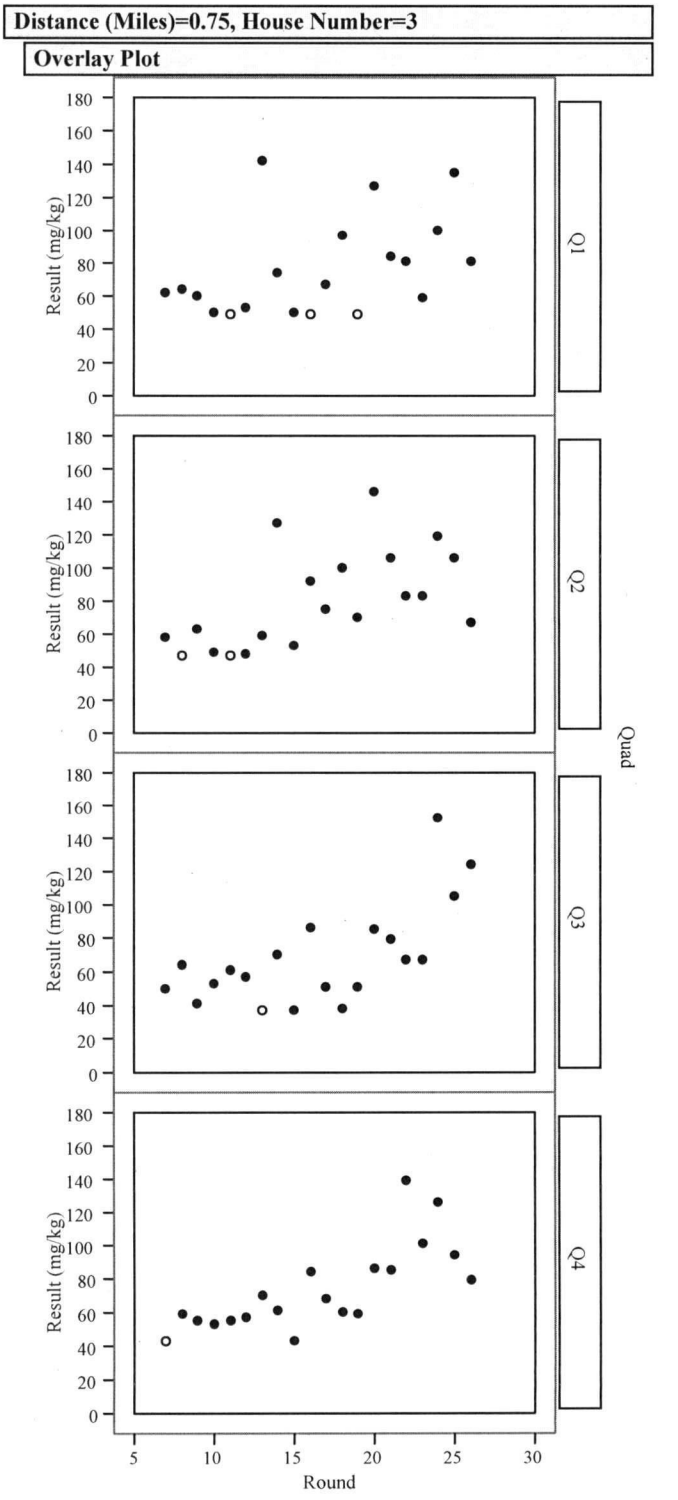


FIGURE 1. Lead Concentration Trends From Round 7 Through 26, Houses Sorted By Increasing Distance From the Smelter (Cont)

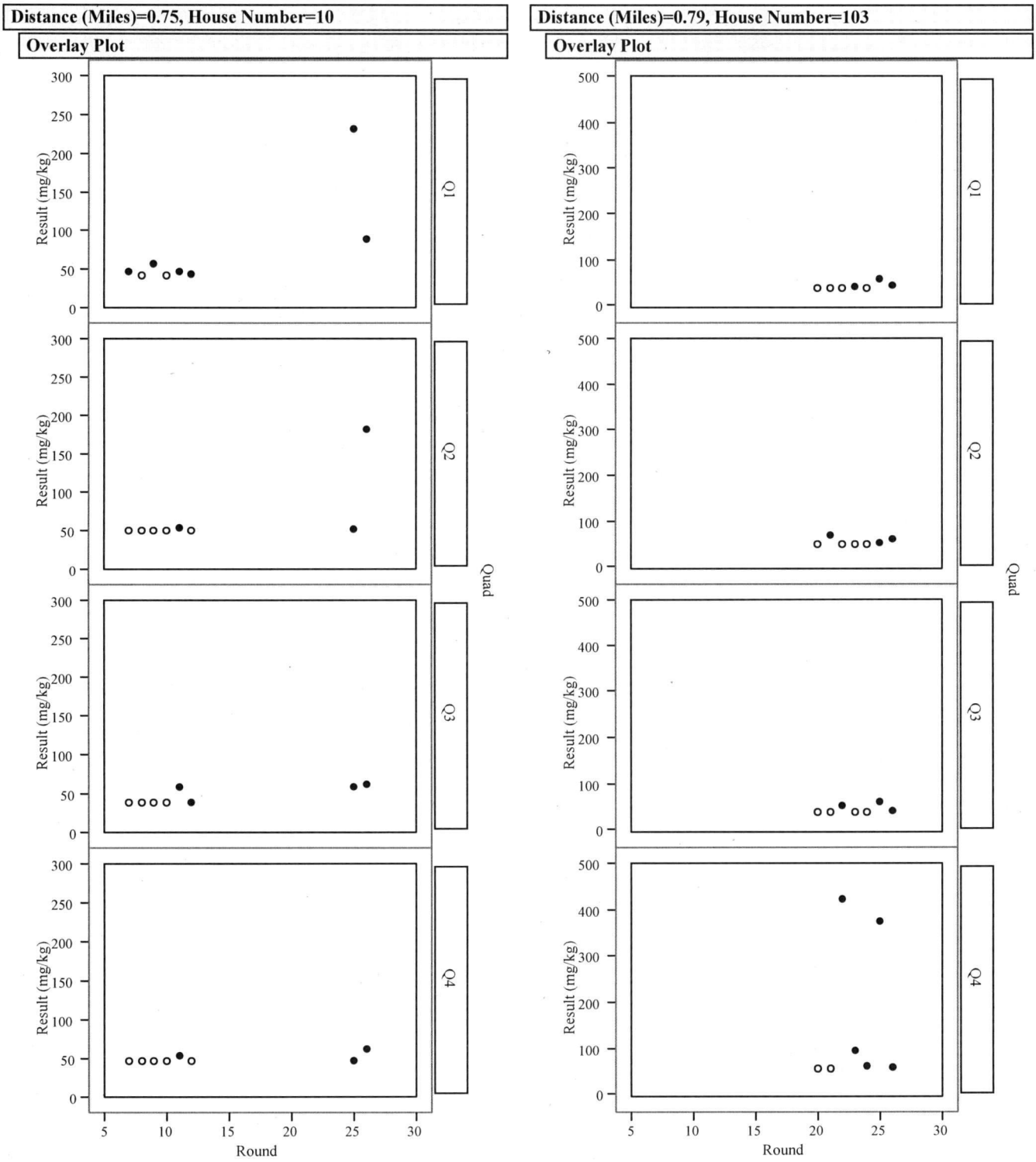


FIGURE 1. Lead Concentration Trends From Round 7 Through 26, Houses Sorted By Increasing Distance From the Smelter (Cont)